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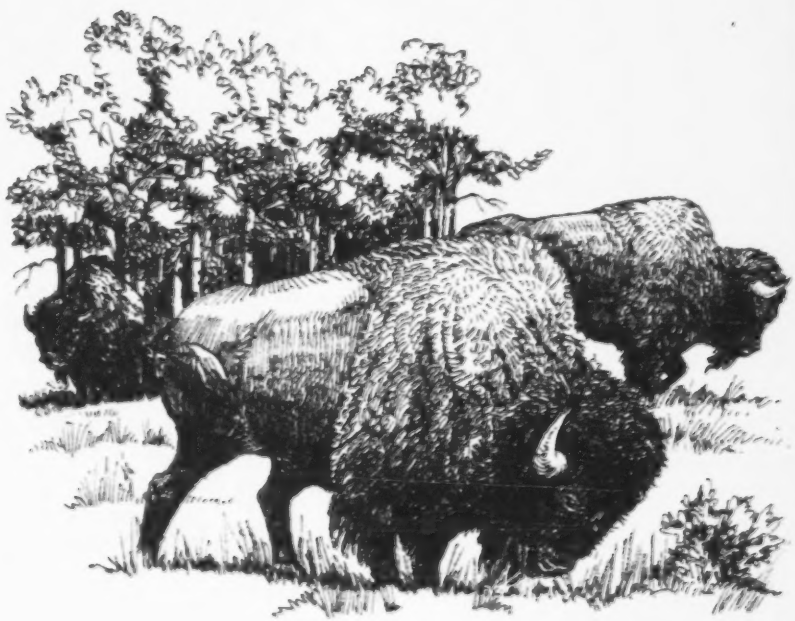
Status of the Wood Bison (*Bison bison athabascae*) in Alberta

Jonathan A. Mitchell
and
C. Cormack Gates



Alberta Wildlife Status Report No. 38

Alberta Conservation Association

Alberta
SUSTAINABLE RESOURCE DEVELOPMENT

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PREFACE

Every five years, the Fish and Wildlife Division of Alberta Sustainable Resource Development reviews the status of wildlife species in Alberta. These overviews, which have been conducted in 1991, 1996 and 2000, assign individual species "ranks" that reflect the perceived level of risk to populations that occur in the province. Such designations are determined from extensive consultations with professional and amateur biologists, and from a variety of readily available sources of population data. A primary objective of these reviews is to identify species that may be considered for more detailed status determinations.

The Alberta Wildlife Status Report Series is an extension of the general statusing exercises (1996 *Status of Alberta Wildlife*, *The General Status of Alberta Wild Species* 2000), and provides comprehensive current summaries of the biological status of selected wildlife species in Alberta. Priority is given to species that are potentially at risk in the province ("At Risk," "May Be At Risk"), that are of uncertain status ("Undetermined"), or which are considered to be at risk at a national level by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

Reports in this series are published and distributed by the Alberta Conservation Association and the Fish and Wildlife Division of Alberta Sustainable Resource Development. They are intended to provide detailed and up-to-date information which will be useful to resource professionals for managing populations of species and their habitats in the province. The reports are also designed to provide current information which will assist the Alberta Endangered Species Conservation Committee to identify species that may be formally designated as "Endangered" or "Threatened" under Alberta's *Wildlife Act*. To achieve these goals, the reports have been authored and/or reviewed by individuals with unique local expertise in the biology and management of each species.

EXECUTIVE SUMMARY

The wood bison (*Bison bison athabascae*) is the largest terrestrial mammal in North America and originally was scattered in small, non-migratory herds from northern Alberta to Alaska. Like the plains bison (*Bison bison bison*), hunting nearly eliminated the wood bison at the end of the 19th century, when the species' population reached an estimated low of 250. The bison has been an important element of the fauna of Alberta for nearly 10 000 years, providing sustenance and materials for many of Alberta's first human residents. Bison also provide an important source of food to wolves and other animals that scavenge their carcasses. Wood bison are considered obligate grazers, primarily consuming the grasses and sedges found in the small prairies of the boreal forest. Bison may be partially responsible for maintaining these habitats. Fire suppression, disruption of flood regimes and the disappearance of bison from northern Alberta have likely combined to result in forest encroachment and eventual loss of some of these boreal prairies.

Reintroduction efforts have been undertaken in northern Canada, including one location in Alberta. The Hay-Zama herd located near Assumption, Alberta was estimated to number 200 animals in March 2001. However, this herd may be threatened by the wood bison in and around Wood Buffalo National Park (WBNP), which are infected with the cattle diseases of bovine tuberculosis and bovine brucellosis. The presence of these diseases is the most significant factor limiting further recovery of Wood Bison in Alberta. Other pressures include expansion of agriculture in the boreal region, in particular commercial bison ranching, and increasing industrialization of northern parts of the province. Disease surveillance measures for the Hay-Zama herd need to be developed to protect these animals from infection.

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) lists the Wood Bison as "Threatened" but does not provide a designation for plains bison (COSEWIC 2001). Wood bison and plains bison are aggregated under the taxonomic designation *Bos bison* by the Canadian Endangered Species Council (2001), which lists the species as "Sensitive" in Canada. In Alberta, the wood bison is considered "At Risk" according to *The General Status of Alberta Wild Species 2000* (Alberta Sustainable Resource Development 2001). Within a designated management area in the northwestern section of the province, bison are listed as "Endangered" under Alberta's *Wildlife Act*. Additional research needs to be conducted to determine the status of bison between Hay-Zama and WBNP, and other areas in northern Alberta.

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INTRODUCTION

Alberta lies within the "Great Bison Belt" that extended across Eurasia, through Beringea and southward across North America (Guthrie 1980, 1990). During the Holocene, bison were widely distributed throughout North America, from the eastern woodlands to northwestern Canada and Alaska (Soper 1941, Dary 1989, Stephenson et al., in press). The phenomenon of large migratory populations was unique to the Holocene Great Plains, with its vast expanse of contiguous grasslands (Guthrie 1980, 1982, 1990). In contrast to the plains bison, the wood bison was scattered in small, non-migratory herds from northern Alberta to Alaska (Gates et al. 1992, Stephenson et al., in press). Like the plains bison, the wood bison was pushed close to extinction late in the 19th century (Gates et al. 1992, Isenberg 2000).

The bison has been an important element of the fauna of Alberta for nearly 10 000 years, since the end of the Wisconsin glacial period. It provided sustenance and materials for many of Alberta's first human residents. It was a source of food for early explorers and a staple for the fur trade and early European settlements. The wood bison appears on provincial, national and international lists of species at risk. In Alberta, it is considered "At Risk"* according to *The General Status of Alberta Wild Species 2000* (Alberta Sustainable Resource Development 2001) and is listed as "Endangered" under Alberta's *Wildlife Act*. Reintroduction efforts have been undertaken in five locations in the wood bison's original range in Canada (Gates et al. 2001), including one location in Alberta near Assumption. The presence of cattle diseases in the metapopulation surrounding Wood Buffalo National Park (WBNP) is one of the greatest threats to the recovery and maintenance of healthy wood bison populations in northern Canada (Gates et al. 2001) and is the most significant factor limiting further recovery in Alberta. Other pressures include expansion of agriculture in the boreal region, in particular commercial bison ranching, and increasing industrialization of northern parts of the province. This report summarizes the history and ecology of the wood bison, causes for its decline, current pressures, recovery and conservation efforts, and its current status in Alberta.

* See Appendix 1 for definitions of selected status designations.

HABITAT

The wood bison is an obligate grazer, requiring habitat that provides grasses and sedges which make up the majority of its winter diet (Larter and Gates 1991). Wetland-associated meadows, open savanna-like shrublands, and dry grasslands are the most important habitat types for wood bison in the boreal forest (Reynolds et al. 1978, Larter and Gates 1991). However, they may use a wider range of habitats and forage plants in other seasons. In the summer, wood bison in the Mackenzie population occupy grass and/or sedge (*Carex* spp.) meadows until mid-to late-summer when they form small herds and move to coniferous and mixed forests (Larter and Gates 1991). In addition to grasses and sedges, the early-to mid-summer diet may contain a large quantity of willow leaves (Reynolds et al. 1978, Reynolds and Hawley 1987, Larter and Gates 1991). Lichens are found to be an important dietary component for a short time in the fall if they are available in open canopy forests surrounding meadows or grasslands (Larter and Gates 1991).

As obligate grazers, bison are associated with graminoid- (grasses and sedges) dominated plant communities. The best described and currently occupied wood bison habitat is found in the lowlands of the Peace, Athabasca and Slave rivers (Reynolds 1987, Timoney 1996). The wet meadows in these areas are dominated by sedge and bluejoint (*Calamagrostis* spp.). Broad

vegetation zones within the wet meadows follow a moisture gradient related to slight changes in elevation from the water bodies. Hogenbirk and Wein (1991) described three zones in northern Alberta, including a sedge marsh in the wettest sites, a bluejoint meadow in the next upslope area, followed by a willow (*Salix* spp.) savanna zone in the driest sites. These zones correspond to similar habitat types used by bison in the Slave River Lowlands (Reynolds et al. 1978) and in the Mackenzie wood bison range in the Northwest Territories (Larter and Gates 1991).

Moss (1953) described wet meadows as being widely scattered over northern Alberta. They are maintained by periodic flooding which makes areas unsuitable for dry meadow species. Changes to natural flood patterns can alter the stability of wet meadows. The amplitude of seasonal water level fluctuations in the Peace-Athabasca Delta was reduced after completion of the W.A.C. Bennett Dam constructed in the Peace River in British Columbia (Muzik 1986). Prior to construction of the dam in 1968, succession from graminoid-dominated plant communities to willow and tree species was delayed or reversed by periodic flooding (Dirschl et al. 1974). Since the dam was constructed, meadows associated with low-lying terrain in the Lower Peace and Slave River drainages have been reduced by shrub and tree encroachment (Jacques 1990, English et al. 1995, Timoney et al. 1997). Similarly, reduction of meadows resulting from the dam has been observed west of WBNP in the Wabasca and Mikkwa River Lowlands where the seasonal flood regime has also been altered (V. Neal, pers. comm.).

Fire was used by early inhabitants of northern Alberta to maintain meadows prior to the advent of modern forest management (Lewis 1977, 1980, Lewis and Fergusen 1988). In the High Level - Fort Vermilion area, large areas were still being burned by Aboriginal people just prior to World War II (Lewis 1977). Burning typically took place in early spring, just after snowmelt when grasses were dry in open areas, and the forest understory was still wet. The most common reason for burning was to provide better forage for herbivores, including horses and bison. Meadows were burned west of WBNP to attract bison so that they could be legally hunted outside the park (Lewis 1977).

In addition to habitat changes resulting from fire suppression, climate change, caused by an increase in greenhouse gases, is expected to have major impacts on northern vegetation by exposing plants to environmental stresses such as increased temperature and evapotranspiration (Pastor and Post 1988). In addition to human interference with flood regimes, wet meadows in the boreal region of Alberta may be subject to stress from climate change. This may lead to increased invasion by willows (Timoney 1997) and exotic plant species (Hogenbirk and Wein 1991, 1992), and in turn the loss of habitat for wood bison.

The boreal region of Alberta also contains dry grasslands, which include some plant species (*Stipa spartea*, *Artemisia frigida*, *Danthonia intermedia*) that are representative of true grasslands located much further south in the province (Wilkinson and Johnson 1983). The largest of these grasslands occur in the Peace River District, which are now primarily occupied by agricultural activity. However, some smaller dry grassland patches are still scattered as far north as WBNP (Raup 1935, Moss 1952, Redmann and Schwarz 1986). Of particular importance are the grasslands and meadows of the Peace and Athabasca rivers, especially the delta that formed at their juncture near Lake Claire within WBNP. It also appears that habitat was once present in the Fort McMurray area, along the tributaries of the Clearwater River, and west towards the Birch Mountains (Roe 1951). These prairies were historically associated with dark, solonetzic soils

in the region, whereas forested areas tended to correlate with lighter soils (Wilkinson and Johnson 1983). Encroachment by the boreal forest trees onto dark soils is evidence of the past presence of prairies and their subsequent disappearance (Wilkinson and Johnson 1983). The loss of many of these prairies to forest succession may be attributed to the disappearance of bison from the northern regions of the province, and active fire suppression in the region. Campbell et al. (1994) offered similar explanations regarding the disappearance of the plains bison and aspen expansion in western Canada. Although there were large prairies in the Peace River and Grand Prairie areas of the boreal region, many other small prairies and meadows were scattered from the Rockies to the Canadian Shield (Gates et al. 1992). A range assessment conducted in the Hay-Zama lakes area indicated that there is a significant amount of good bison habitat with the potential to support as many as 2000 individuals (Reynolds et al. 1982). The presence of excellent habitat in the Hay-Zama lakes area was also confirmed through a habitat-mapping project conducted in 2000 (Wright and Markiewicz 2000). The wood bison's affinity for relatively small, widely dispersed graminoid habitat patches, likely means that they existed as a metapopulation consisting of many connected sub-populations scattered widely throughout northern Alberta.

CONSERVATION BIOLOGY

The wood bison is the largest terrestrial mammal in North America (Reynolds et al.1987). Males have a massive triangular head, large shoulders with a high hump, and dense shaggy dark brown and black hair around the head and neck (van Zyll de Jong et al. 1995). They possess short, thick, black horns that end in an upward curve. Females possess thinner, more curved horns (Fuller 1962). Pelage varies in length over the body. Hair on the head is longer and less woolly than on the plains bison. The beard, throat mane, cape and chaps are typically less pronounced in wood bison than for plains bison (Figure 1). The pelage is composed of long, coarse guard hairs, with a woolly undercoat (Banfield 1974). Hair on the head is darker than on the remainder of the body. Bison moult twice during the year; once in the spring and again in the fall (Reynolds et al. 1987). They have a thick dermal shield between the horns and on the forehead and thick skin on the neck, which provides protection during sparring.

There is marked sexual dimorphism in body size. Reliable comparative data for male wood bison have not been published. However, mature male plains bison are 1.65 times heavier than mature females (Renecker et al., 1989). Female wood bison at Elk Island National Park weigh 564 kg at maturity, and are on average about 100 kg heavier than plains bison females (Renecker et al. 1989). Male bison reach reproductive maturity at one to two years of age; however, juveniles (one to two years) and sub-adult bulls (three to six years) participate infrequently in breeding in the presence of older males (Komers et al. 1994a, b). During the late rut older bulls decrease their involvement in competition for mates, providing limited mating opportunities for younger bulls (Komers et al. 1994b, Wolff 1998). Male reproductive effort increases throughout their lifetime (Komers et al. 1994b). Female bison are physically mature at two years of age and most calve for the first time at three years old. Both sexes can live for up to 20 years in the wild and have been known to live longer than 30 years in captivity (Reynolds et al. 1982). Recent evidence suggests that bison can also live beyond 20 years in the wild. A 27-year-old female bison (born 29 October 1968, died 3 November 1995) was killed by a vehicle east of Habay, Alberta, and became the oldest wild bison on record (K. Morton, pers. comm.). Most calves are born during May to early June, after a gestation of approximately 270 to 300 days (Banfield 1974). Typically only one calf is born (Lott and Galland 1985). Neonates

are light reddish brown in colour without the distinctive body shape of the adults.

The wood bison (*Bison bison athabascae*) is a recognized subspecies of the North American bison (Raup 1933, Soper 1941, Skinner and Kaisen 1947, Banfield and Novakowski 1960, Flerov 1965, Karsten 1975, Geist and Karsten 1977, Cook and Muir 1984, van Zyll de Jong 1986, FEARO 1990). Some taxonomists believe that because cattle (*Bos*) and bison are morphologically and genetically similar, they should be united in a single genus (Simpson 1961, Van Gelden 1977). This is supported by morphological (Groves 1981) and genetic evidence (Miyamoto et al. 1989, Wall et al. 1992, Janecek et al. 1996), as well as the partial ability of cattle and bison to hybridize (Van Gelden 1977). Jones et al. (1997) included bison and cattle in a single genus in their checklist of North American mammals; they continued the "somewhat unpopular decision to use the name combination of *Bos bison* for the American bison". However, the American Society of Mammalogists (http://www.mammalsociety.org) lists the bison (*Bos bison*) as a separate genus from *Bos*, following the taxonomy of Wilson and Reeder (1993). Because of a lack of consensus on the taxonomy of the *Bos* and *Bison*, the wood bison Recovery Team (Gates et al. 2001) continues to

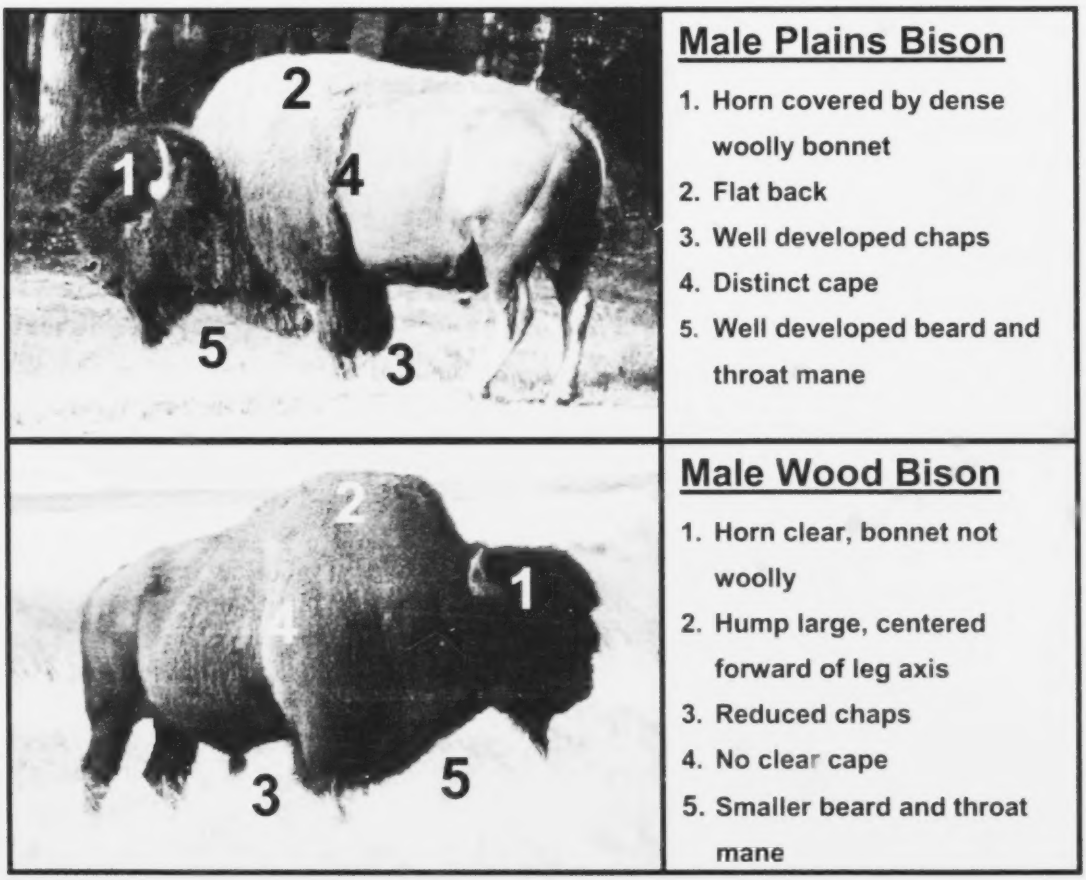
Male Plains Bison
1. Horn covered by dense woolly bonnet
2. Flat back
3. Well developed chaps
4. Distinct cape
5. Well developed beard and throat mane
Male Wood Bison
1. Horn clear, bonnet not woolly
2. Hump large, centered forward of leg axis
3. Reduced chaps
4. No clear cape
5. Smaller beard and throat mane

Figure 1. Physical differences between wood and plains bison.

refer to wood bison as *Bison bison athabascae*. However, in a recently released document on the general status of species in Canada (CESCC 2001), both subspecies were listed under the common designation *Bos bison*. The inconsistency associated with trinomial taxonomic designation of bison in Canada could lead to difficulty in maintaining separate conservation of genetic differences between the two forms in the long term.

Quantifiable differences between plains bison and wood bison in cranial and skeletal morphology were reported by van Zyll de Jong in 1986. However, when the destruction of tuberculosis and brucellosis infected bison in Wood Buffalo National Park was suggested (FEARO 1990), questions were raised about the validity of the wood bison as a subspecies. Geist (1991) suggested that subspecies status is not warranted and that observed differences between plains bison and wood bison are environmentally induced. Strobeck et al. (1993) compared sequence divergence in a section of D-loop in the mtDNA of a small number of wood and plains bison and found that differences between the two subspecies are approximately the same or less than within plains bison. The rate of sequence divergence in mtDNA is on the order of 1% to 2% per million years (Wilson et al. 1985). These findings are consistent with the view that wood bison and plains bison existed as reproductively isolated populations during the last 5000 to 10 000 years, a relatively short time in evolutionary terms, and that there was introgression of plains bison mtDNA into remnant wood bison populations during the 1920s (van Zyll de Jong et al. 1995). Recent work on morphological (van Zyll de Jong et al. 1995) and genetic differences (Wilson and Strobeck 1999) between wood and plains bison indicate that wood bison continue to function as a genetic entity separate from plains bison, despite the introduction of plains bison in the 1920s. These findings support the view that the wood bison is sufficiently distinctive to warrant conservation as an entity separate from plains bison (Wilson and Strobeck 1999, Gates et al. 2001).

Wood bison are ruminant herbivores whose ecological role is as a primary grazer of coarse grasses and sedges. They occupy a niche that is not used by other northern herbivores (Reynolds et al. 1978, Larter and Gates 1991). Grazing by bison influences the structure of plant communities and cycling of nutrients (Frank and McNaughton 1992, Frank and Evans 1997). Bison also physically influence the landscape. Their wallows and trails disturb the ground, providing microhabitat sites for species that favour disturbed sites (Polley and Collins 1984). It has also been postulated that bison play a role in maintaining meadow habitat and overall biodiversity of the regions they inhabit (Campbell et al. 1994, Zimov et al. 1995).

There is very little dietary overlap between bison and other ungulates in the north. Therefore, the potential for direct competition for resources is minimal (L. Fischer, pers. comm., Gates et al. 2001). However, bison may affect other ungulate populations through predator mediated interference when wolf populations respond numerically to an increased abundance of bison as prey (Larter et al. 1994). Bison provide a source of food for wolves (Carbyn and Trottier 1988) and may also provide an important source of food for other animals that scavenge on their carcasses (Green et al. 1997). Wolves are thought to regulate small bison populations (Van Camp and Calef 1987, Carbyn and Trottier 1988, Carbyn et al. 1993, Carbyn et al. 1998) and may have an additional impact on herds infected with brucellosis and tuberculosis (Messier 1989, Gates 1993).

DISTRIBUTION

The original range of wood bison in Canada is approximately 1 823 000 km^2; however, a large part of that range is no longer available (Gates et

al. 2001). In Alberta and British Columbia, industrial, agricultural and urban development, and forest succession have altered a significant proportion of the range.

1. Alberta. - Wood bison were widely scattered in low numbers throughout the northern portions of Alberta (van Zyll de Jong 1986, Gates et al. 2001) (Figure 2). Early accounts of bison were provided by explorers and indigenous peoples for many areas in northern Alberta including WBNP (Soper 1941), the Fort Vermilion area, the Birch Mountains, and the Fort McMurray area (Roe 1951). Additional evidence is reflected in locations like Wood Bison Lake and Buffalo Head Hills. By the late 1800s, wood bison had been nearly extirpated from Alberta. Small numbers persisted in the area designated in 1922 as Wood Buffalo National Park (Soper 1941). Wood bison were reported near the Wabasca River and Fort Vermilion area as late as 1926 (Soper 1941, Novakowski 1957).

WBNP continues to sustain a wood bison population throughout the park. The reintroduced population in the Assumption area in northwestern Alberta is expanding its range as the population increases (Figure 3). The Hay-Zama wetland complex mainly occupied by this herd covers over 500 km^2 (Wright and Markieweicz 2000). During the 1990s, sightings of bison were reported in several locations between 70 km and 140 km from Hay-Zama Lakes along Highway 35, north and south of High Level and in the Paddle Prairie area south of the Chinchaga River (Figure 3).

Recent reports from local people indicate that bison still occupy other areas in northern Alberta outside of Wood Buffalo National Park including the Wabasca and Mikkwa Lowlands, Wentzel River area, Talbot Lake, and the Buffalo Head Hills (J. Mitchell, in prep.). However, little information is available on the number of bison, their distribution, or population trends (Gates et al. 2001). Hunting pressure in the area outside of the designated management area (Figure 3) is a potentially significant limiting factor and may affect the distribution of these herds (Gainer 1985, Tessaro 1988, J. Mitchell, in prep.).

2. Other Areas. - The current distribution of wood bison in North America reflects extensive recovery initiatives and thorough research and is therefore well documented (FEARO 1990, Gates et al. 1992, McCormack 1992, Gates et al. 2001, Stephenson et al., in press,). The timeline in Appendix 2 provides a brief summary of the history of wood bison in Alberta.

POPULATION SIZE AND TRENDS

Wood bison populations in Canada can be categorized into four classes (Gates et al. 2001): (1) free-ranging populations; (2) free-ranging , diseased populations (infected with tuberculosis and brucellosis; (3) captive populations; and (4) privately owned herds with conservation objectives. While, there are also wood bison in privately owned commercial herds, these are not considered to be contributing to recovery under the national recovery program (Gates et al. 2001).

1.0 Alberta

1.1 FREE-RANGING

Hay-Zama Herd. - In 1981, a program was initiated to re-establish a disease-free, free-ranging population of wood bison in their original range in northwestern Alberta. In cooperation with the Dene Tha' First Nation (DTFN), a 3 km^2 holding corral was constructed northeast of Habay, Alberta. In February 1984, 29 wood bison were transported to the site from EINP. Although the release of wood bison to northern Alberta was initially scheduled to occur in 1988, the risk of infection with bovine tuberculosis and brucellosis from free-ranging bison in the greater WBNP area resulted in a delay of this activity. The number of bison increased to 49 animals in 1993 when they became a free-ranging population after portions of the fence surrounding the enclosure collapsed.

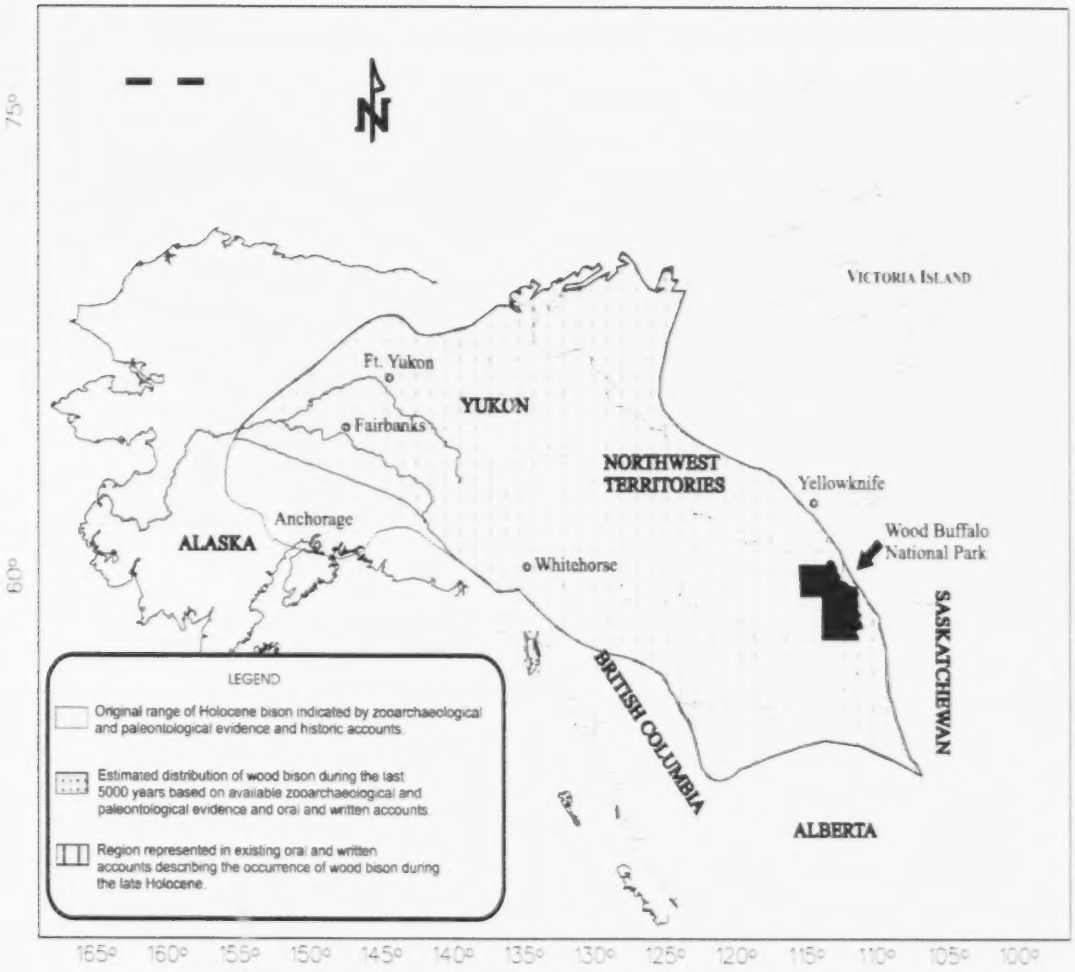
75°
60°
Victoria Island
Ft. Yukon
YUKON
Fairbanks
NORTHWEST TERRITORIES
Yellowknife
Anchorage
ALASKA
Wood Buffalo National Park
Whitehorse
SASKATCHEWAN
BRITISH COLUMBIA
ALBERTA
LEGEND
Original range of Holocene bison indicated by zooarchaeological and paleontological evidence and historic accounts.
Estimated distribution of wood bison during the last 5000 years based on available zooarchaeological and paleontological evidence and oral and written accounts.
Region represented in existing oral and written accounts describing the occurrence of wood bison during the late Holocene.
165° 160° 155° 150° 145° 140° 135° 130° 125° 120° 115° 110° 105° 100°

Figure 2. Original and late Holocene range of wood bison in North America based on available zooarchaeological, paleontological, oral and written historical documentation. Reprinted with permission from Gates et al. 2001.

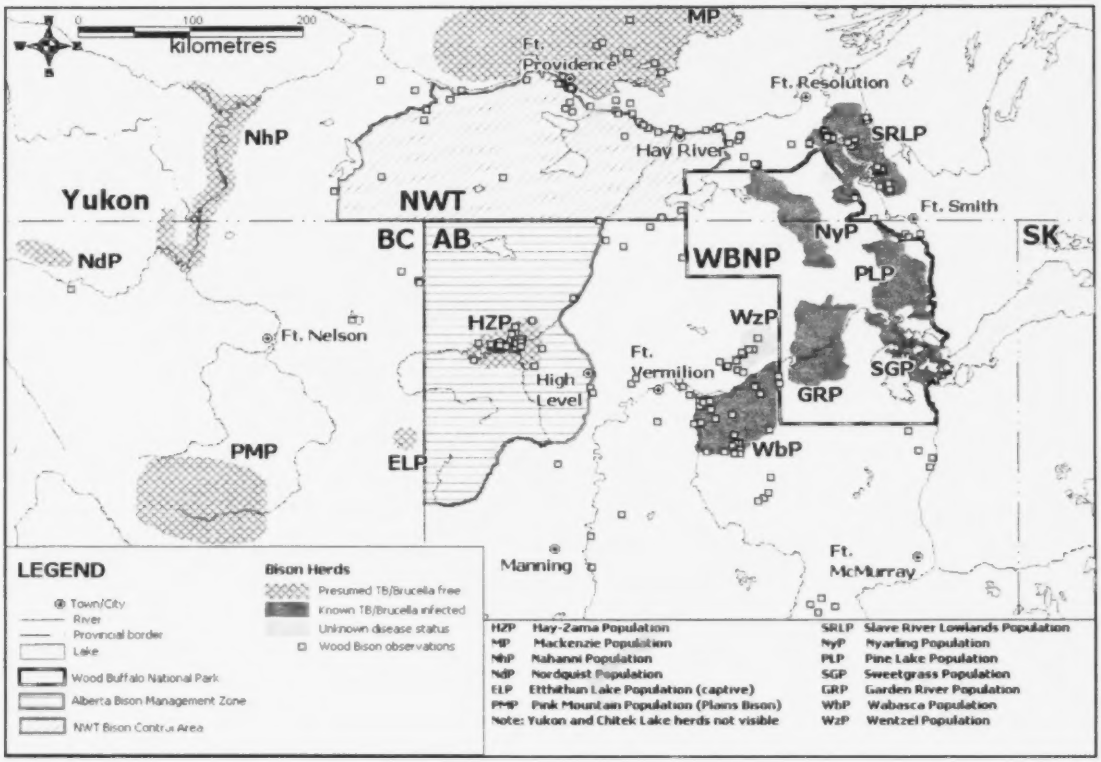

Figure 3. Bison distribution and management zones in northern Canada. Bison observation data is an aggregate of confirmed and unconfirmed reported observations from 1976-2001, maintained at the University of Calgary by Dr. C. Cormack Gates.

The herd has generally remained in the area and tends to range in suitable habitat near the Chinchaga River and the Hay-Zama Lakes complex. Wood bison from the Hay-Zama herd occasionally wander into the Hay River drainage in northeastern British Columbia (Gates et al. 2001). They may have also expanded eastward into areas north and south of High Level (Figure 3). The herd has continued to increase in size; the population was estimated at 200 in March 2001 (D. Moyles, pers. comm.).

The government of Alberta created a wildlife management area approximately 40 350 km^2 in size in the northwestern corner of the province to manage the Hay Zama wood bison herd (Figure 3). In addition, the High Level Tribal Council (HLTC, now called the North Peace Tribal Council) agreed to not hunt bison in this area (Morton 1999). The Hay-Zama herd could potentially contribute to the national recovery program if it is allowed to increase to 400 animals (Gates et al. 2001). However, in a 1985 agreement between the government of Alberta (Alberta Fish and Wildlife Division), the Canadian Wildlife Service, and the Dene Tha' First Nation, it was decided that the herd will be maintained through hunting at approximately 250 animals until the WBNP disease issue is resolved (Gates et al. 2001).

Mortality was recorded for the Hay-Zama herd when observed (Table 1). Twenty-eight deaths have been recorded for this population (K. Morton, pers. comm.). It is unlikely that all deaths were documented. Eight mature bulls were culled by managers prior to the release of the herd. Collisions with vehicles represent the largest source of uncontrolled known mortality. All mortalities from the Hay-Zama herd are tested for brucellosis and tuberculosis, when possible, and as of 31 March 2001 all have tested negative for the two diseases (D. Moyles, pers. comm.).

Bison in Alberta that range outside of the designated bison management zone and WBNP are not considered wildlife under Alberta's *Wildlife Act*, and are not protected from hunting. The area between the wildlife management area and WBNP can be considered as an unmanaged buffer zone for reducing the probability of disease transmission to the Hay-Zama herd. Although limited information is available for bison outside of WBNP and the management zone, Alberta Fisheries and Wildlife Management Division conducted an aerial moose survey in 1996. The survey counted 51 bison as incidental sightings in two herds that range near the Mikkwa and Wabasca Rivers, south of the Peace River near the boundary of WBNP. A limited survey conducted for brucellosis and tuberculosis was also conducted in the 1980s in this area (Tessaro 1989). Six animals were tested outside of WBNP and south of the Peace River; *Brucella abortus*, the causative agent for brucellosis, was cultured from one animal. Based upon this positive test and local information indicating transboundary movements into and out of WBNP, the bison herds south of the Peace River are considered to be infected with tuberculosis and brucellosis.

Wentzel Lake Herd. - Another herd of bison ranges between Wentzel Lake and the southwest

Table 1. Recorded mortalities of wood bison in the Hay-Zama herd as of 31 March 2001. (K. Morton, pers. comm. 2001).

Cause of Mortality	Culled	Vehicle Collisions	Predation	Natural Causes	Trampled	Unconfirmed	Total Mortalities
# of Mortalities	8	8	3	2	1	6	28

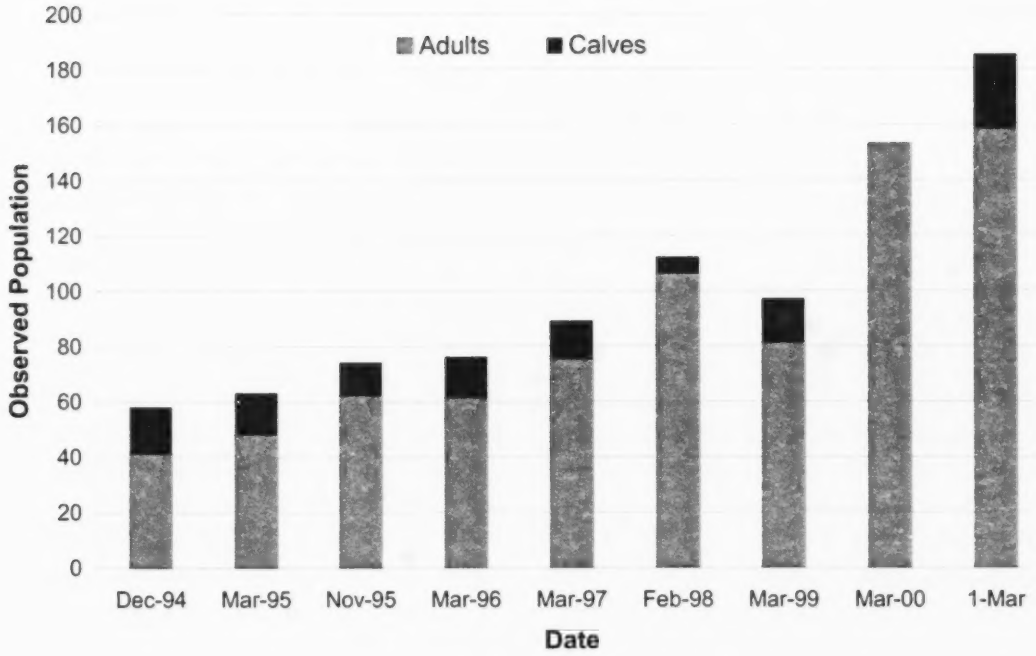

Figure 4. Size and composition of the Hay-Zama herd between 1994 and 2000 from aerial survey information. Calves were not counted in 2000 (Morton 1999, Wright and Markiewicz 2000).

border of WBNP, north of the Peace River. Very little information is available for this population, with population estimates ranging from 25 to 110 animals (Gates et al. 2001). The relationship between this herd and the animals inside WBNP is unknown; however, local information indicates that there is movement between these populations (J. Mitchell, in prep.). Additional information on the movements of the Wentzel herd, their habitat use and disease status needs to be gathered.

1.2 CAPTIVE

Syncrude Canada Ltd. Herd. - In addition to the free-ranging herds, in 1993 Alberta Environmental Protection, the Canadian Wildlife Service, Syncrude Canada Ltd. and the Fort McKay First Nation cooperatively established a captive breeding herd north of Fort McMurray. The wood bison were acquired from Elk Island National Park (EINP). The herd is located on Syncrude Canada Ltd. oil sands lease property in a reclamation area approximately 2.6 km^2 in size. The bison within the fenced pasture became the property of Syncrude Canada Ltd. in 1995, when Alberta's *Wildlife Act* no longer differentiated subspecies of bison therefore changing the status of the wood bison outside the protected area from wild to domestic (Gates et al. 2001). Prior to calving in 1999, the herd numbered 141 animals.

Elk Island National Park (EINP). - There are also some captive breeding populations of wood bison. EINP is located east of Edmonton, Alberta. The park has approximately 350 wood bison; there is also a substantial population of plains bison. The two herds are separated by a four lane divided highway and fencing. The wood bison herd is currently increasing and is managed

as a source population for the creation of disease-free wood bison herds.

2.0 Other Areas

2.1 FREE-RANGING

There are a number of reintroduced herds in northern Canada, two of which have exceeded the minimum viable population (MVP) objective of 400 bison prescribed by the Wood Bison Recovery Team (Gates et al. 2001).

Mackenzie Bison Range Herd. - The population found in the Mackenzie Bison Range in the Northwest Territories was the first re-established herd in the wild to reach the MVP. It was founded in 1963 with the transfer of 18 bison from the Nyarling River region of WBNP. Currently the herd is the largest disease-free wild population in Canada. It numbers approximately 2000 animals, and is increasing (J. Nishi, pers. comm.). Limited hunting is permitted to regulate the population.

Yukon Herd. - The second disease-free wild herd to reach the MVP objective was established in the Yukon with several releases totalling 170 between 1986 and 1992. The Yukon herd was about 450 in late winter 1999. Hunting is used to maintain the population under 500 (Yukon Government 1998).

Nahanni Populations. - The other disease-free, free-ranging herds were founded with stock originating or derived from EINP. The Nahanni herd ranges in the Liard River drainage in the Northwest Territories and northern British Columbia. It was established through releases in 1980, 1989 and 1998. It is currently estimated at 170 animals.

Nordquist Population. - Another herd was reintroduced into northeastern British Columbia in March 1995 in the Nordquist Flats area (Aline Lake) in the Upper Liard River Valley. The exact status of this population is unknown; 39 bison were counted prior to calving in 2000. The herd is currently estimated to number 60 animals (Gates et al., in press). The proximity of this site to the southern range of the Nahanni herd (approximately 80 km along the Beaver River) leads experts to believe that these two herds will eventually coalesce (Gates et al., in press). This herd is also expected to reach the MVP objective of at least 400 bison.

2.2 CAPTIVE WITH CONSERVATION OBJECTIVES

Ettithum Lake. - There are two public captive breeding projects in northern Canada. The Etthithun Lake herd is located in northeastern British Columbia near Etthithun and Kantah Lakes, and the Alberta border. It numbered 43 animals in 2000. The herd will be released to the wild in several years when it is certain that the animals have habituated to the area (Gates et al. 2001).

Hook Lake. - The Hook Lake captive breeding herd was established to salvage genetic resources from a diseased population in the Slave River Lowlands (Gates et al. 1998). Sixty neonatal bison calves were captured to establish the herd. In 2000, there were 65 bison in the herd prior to calving.

2.3 FREE-RANGING/DISEASED

Greater Wood Buffalo National Park (GWBNP). - In addition to these herds there are also free-ranging populations infected with tuberculosis and brucellosis. There are six sub-populations in the (GWBNP) area among which movement has been documented (Joly and Messier 2001). The diseased herds have been in decline (Figure 5) since the termination of active bison management in WBNP around 1970; the WBNP population declined by approximately 80% since 1970, from 16 000 animals in 1971 to approximately 2300 currently (Gates et al. 2001, Joly and Messier 2001). In contrast, disease-

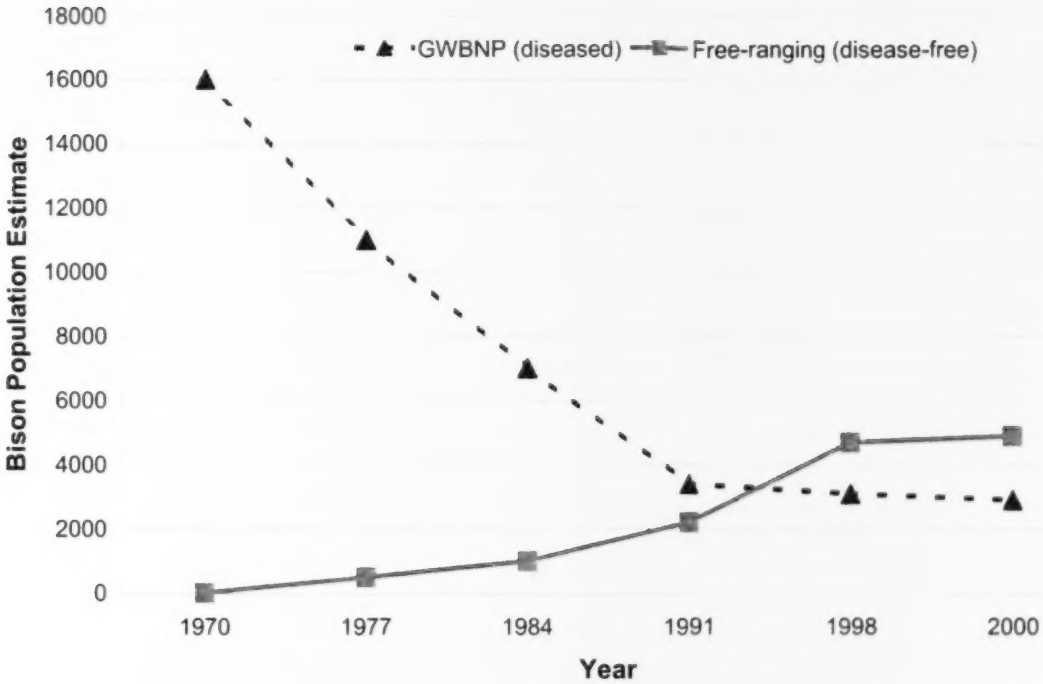

Figure 5. Trends in the number of bison in the Greater Wood Buffalo National Park metapopulation (WBNP and SRL) and in the aggregated number of animals in other free-roaming public wood bison herds.

free, free-ranging herds increased during the same period (Figure 5).

LIMITING FACTORS

1. Disease. - The presence of reportable cattle diseases in bison sub-populations in the Greater Wood Buffalo National Park area is the most difficult issue facing management and recovery of wood bison in Alberta. There are three prevalent diseases that affect the bison populations, particularly those in and around Wood Buffalo National Park: Bovine Tuberculosis, Bovine Brucellosis, and Anthrax.

Bovine tuberculosis and brucellosis occur only in bison in and around Wood Buffalo National Park. Infected herds within the Park appear to be negatively impacted by the presence of the two cattle diseases (Joly and Messier 2001). In addition to being a concern for recovery of healthy wood bison herds in wild populations, these diseases are of concern to the commercial bison and cattle industry. One estimate of the economic consequences of an outbreak in cattle in Canada reported a potential cumulative loss of $1 billion over a 20-year period (FEARO 1990). A summary outlining the history of the two diseases in northern Canada is listed in Appendix 3.

Mycobacterium bovis and *Brucella abortus* are the causative agents of bovine tuberculosis and bovine brucellosis, respectively. The role of the diseases in the population ecology of free-ranging bison is the subject of current research programs in Wood Buffalo National Park (Joly and Messier 2001) and Yellowstone National Park (National Parks Service 1999). The pathobiology of each disease is considered similar in bison and cattle (Tessaro 1989). The main clinical features of

brucellosis are a high incidence (approximately 90%) of abortion during the first pregnancy, following infection the second pregnancy exhibits a 20% abortion rate, and subsequent pregnancies result in less than a 1% abortion rate because of naturally acquired immunity (Davis et al. 1991). The symptoms of the disease also include a low incidence of bursitis leading to arthritis and reduced joint mobility. Transmission occurs through contact with aborted foetuses and infected placentas (FEARO 1990).

Tuberculosis in bison and cattle is primarily a pulmonary disease, although any organ system may be affected. Advanced tuberculosis is generally fatal and is transmitted through infected secretions and excretions (FEARO 1990). Owing to the importance of brucellosis and tuberculosis as diseases communicable from animals to humans, they have been the subject of intensive, long-term eradication programs in livestock populations in Canada and the United States. Bison in the Greater Wood Buffalo National Park area represent the last known reservoir of the diseases in Canada.

In response to these concerns, and at the request of the Canadian Bison Association (CBA), the Animal, Plant and Food Health Risk Assessment Network (APFRAN) of the Canadian Food Inspection Agency (CFIA) conducted a risk assessment. The risk assessment conducted by APFRAN (1998) estimated the probability of invasion by infected bison into an area containing susceptible bison and cattle herds, the probability of contact between an infected and non-infected animal in that region once invasion has occurred, and the probability of disease transmission to an individual animal in each risk group once contact has occurred. It then estimated the economic consequences of disease transmission (APFRAN 1998). Risk was calculated by combining the probability of invasion with the probability of contact once invasion had occurred, then contingent upon invasion and contact, the risk of transmission was factored in to achieve an overall risk of infection. Once that risk was defined, the assessment determined the economic consequences of infection.

The risk assessment for the year 1998 provided the 95% probability of at least one animal becoming infected (APFRAN 1998) in an at risk group (Table 2). Disease-free, free-ranging (wild) bison in the Hay-Zama and Mackenzie populations were at the highest risk of infection, at one in eight years for brucellosis and one in six years for tuberculosis. Additional research has been undertaken to modify this risk assessment to include biogeographical factors that influence movement and local knowledge of bison distribution in the at risk regions, and preliminary results suggest that the risk will increase (Mitchell and Gates 1999).

Anthrax is the third disease present in northern populations of wood bison. It is an infectious, often fatal disease of wild and domestic animals, and humans, caused by an endospore-forming bacterium *Bacillus anthracis*. Anthrax is endemic and has been present in bison populations in the region for a longer period of time than the other two diseases (Ferguson and Laviolette 1992). It is very difficult to control because of its ability to persist in soil as a highly resistant endospore (Gates et al. 1995). Anthrax primarily affects mature male bison and does not appear to play a significant role in population dynamics. However, epidemics continue to occur throughout northern Alberta and the original range of wood bison.

The life history of *B. anthracis* is very different from most other infectious bacteria. Its persistence in the environment depends on extreme virulence, death of its host, and survival of highly resistant, infectious endospores during prolonged periods of time outside the host (Gates et al. 2001). The bacillus replicates rapidly in the animal and once the host succumbs to the infection, scavengers are

Table 2. Risk assessment results indicating infection probabilities and economic consequences based on 1998 conditions (APFRAN 1998).

Disease	Risk parameter	Wild bison	Commercial bison	Cattle
	Probability of invasion	1/10 yrs*	1/ 29.9 yrs	1/ 2.7 yrs
Brucellosis	Probability of infection	1/8 yrs	1/229 yrs	1/1276 yrs
	Cost/outbreak	$5 400 000	$6 500 000	$632 000
	Annual cost	$668 750	$28 384	$495
Tuberculosis	Probability of infection	1/6 yrs	1/173 yrs	1/1,764 yrs
	Cost/outbreak	$5 400 000	$8 200 000	$832 000
	Annual cost	$891 667	$47 399	$472

* Annual probability of one bison from GWBNP meeting a free-ranging bison from another population based on bi-directional movement.

often partially responsible for dispersing the bacillus over large areas (through the digestive process). The microorganism can persist in the soil and vegetation for a number of years until the conditions are appropriate and a host animal presents itself.

Proposals to eliminate the two cattle diseases have raised concern about the genetic diversity of wood bison in recovering disease-free populations (Wilson and Strobeck 1999). The Elk Island National Park herd was established in 1965 from 23 animals from the Nyarling River (NR) area and reached a low of 11 individuals in 1968. This herd has been used as the direct or indirect source of founding stock for five free-ranging populations in Canada, including the Hay-Zama herd in Alberta. The Mackenzie wood bison population was established in 1963 from 18 animals captured from the Nyarling sub-population in WBNP. The issue of low genetic variability in the recovery herds is being addressed under the current national recovery program (Gates et al. 2001). Further work is being undertaken to salvage additional genetic material from tuberculosis and brucellosis infected populations in the Slave River Lowlands (Gates et al. 1998, 2001). A sub-committee of the Wood Bison Recovery Team was formed to evaluate the issue and to develop a strategy to conserve the genetic diversity of wood bison and to enhance the diversity of captive breeding herds.

2. Agriculture. - In the Peace Country of British Columbia, Alberta, and the Northwest Territories there are approximately 250 commercial plains bison herds that hold about 20 000 bison (D. Patten, pers. comm.). The farms are located mainly in the agricultural zones in the two provinces, however, there is a farm in the Northwest Territories near Wood Buffalo National Park,

stocked with wood bison. Two bison farms are located in the agricultural area west of WBNP in Alberta and another is proposed. There is also a ranch located approximately 13 km north of High Level. The number of farms in the region has been increasing at a rate of 15% annually and the number of bison on farms has been increasing at a rate of 25% annually (Hussey 1997). In addition, Alberta Agriculture Food and Rural Development has allowed commercial bison to be grazed on leases on public lands in 47 locations in the province. The implications of this practice are currently under investigation (K. Lyseng, pers. comm.). They include the potential issues of disease transmission to or from wild bison, escape and establishment of feral herds, genetic mixing of escaped commercial bison with wild bison, fencing causing habitat fragmentation for wild herbivores (including wild bison), and agricultural encroachment into existing or potential conservation areas for wild bison.

3. Forestry, Oil and Gas. - Extractive resource development can increase meadow and grassland habitat. It has been suggested that bison recovery potential could benefit from these activities (Gates et al. 2001). However, such integrated management opportunities need to be evaluated as to their overall impacts on the ecosystem and their political feasibility amongst government departments with different land based objectives. A trial project is being conducted by Syncrude Canada and the Fort McKay aboriginal peoples, in cooperation with Candian Wildlife Service and Alberta Sustainable Resource Development, to establish a population of wood bison on an oil sands lease area north of Fort McMurray (Gates et al. 2001). The project is designed to operate as a ranch, but may contribute to the eventual recovery of a free-ranging herd should the risk of tuberculosis and brucellosis infection be eliminated.

4. Hunting. - Aboriginal peoples in the Canadian northwest have a long tradition of association with bison, both having inhabited the region for millennia. Traditionally, these people hunted wood bison for food, clothing, and for use in spiritual ceremonies (Guthrie 1980, Bigstone Cree Nation and Metis People of Kituskeenow 1999). Because of the threatened status of wood bison and the cultural and spiritual significance of the animal, some aboriginal groups have voluntarily refrained from hunting bison. Wood bison represent an important animal in their cultural system of beliefs and values.

Except in the designated Bison Management Area, bison roaming outside WBNP in Alberta are not considered wildlife under the regulations of the province's *Wildlife Act* and as such are not protected and are subject to unregulated hunting. In the area near WBNP re-establishment or growth of existing free-ranging herds is not a desirable goal until the issue of cattle diseases is resolved. Current regulations limit the re-establishment of wood bison populations in a large section of original wood bison range in Alberta. The regulations have generated conflict between the Little Red River Cree Nation/Tall Cree First Nation and non-aboriginal hunters who attempt to take bison in the Wentzel River area. These aboriginal groups wish to protect the Wentzel River herd for a period of time to facilitate studies on disease presence and prevalence, movement patterns, and habitat requirements. The First Nations have expressed a desire to hunt disease-free, free-ranging bison herds in the Caribou Lower Peace Region in the long-term. A management plan has not been developed to achieve this objective however, the objective was identified in the National Wood Bison Recovery Plan (Gates et al. 2001).

The only free-ranging bison populations that are subject to regulated hunting in Canada (quotas and permits) are the Yukon wood bison population, the Mackenzie wood bison population, the Slave River Lowlands populations, and the Pink Mountain plains bison herd (Gates et al. 2001).

5. Management. - Both fire suppression and hydrological development have contributed to habitat change in northern Alberta. Suppression of fire in the region has contributed to the conversion of meadow habitat to aspen dominated forests, hence reducing the available forage for bison populations and the overall carrying capacity of the region (McCormack 1992). It has been postulated that the combination of human-use and management of fire during the last 50 years, and the historic decline or absence of grazing by bison may have contributed to a reduction in habitat (Campbell et al. 1994, Gates et al. 2001). The construction of the W.A.C. Bennett Dam on the Peace River in British Columbia has altered the hydrological regime in the Peace–Athabasca Delta, resulting in the reduction of the seasonal flooding in the region (McCormack 1992). In the absence of flooding, some riparian meadow areas are lost to willow invasion (Jacques 1990, English et al. 1995, Timoney et al. 1997). Other management actions have impacted the recovery potential for bison in Alberta. Introduction of free-ranging plains bison populations into parts of the original range of wood bison in British Columbia and Alaska limit the opportunity for wood bison reintroductions and threatens the genetic integrity of adjacent wood bison populations.

STATUS DESIGNATIONS

1. Alberta. - Wood bison are "Endangered" under the authority of Alberta's *Wildlife Act*. According to *The General Status of Alberta Wild Species 2000* (Alberta Sustainable Resource Development 2001) wood bison are considered "At Risk" in the province. The Alberta Natural Heritage Information Centre ranks the subspecies as S1 because of the localized populations of wood bison (ANHIC 2001). The Government of Alberta established a Bison Management Area in the northwest portion of the province in 1995. This zone connects with the Bison Control Area of the Northwest Territories and is adjacent to the British Columbia wood bison management area. It was established to provide regulatory authority for managing the Hay-Zama wood bison population. The Wildlife Regulation states that "Only *Bison bison* (Bison) that are found or killed on or captured from the lands within the following boundaries are endangered animals," and it goes on to describe the boundaries of the Bison Management Area. Bison are protected in this zone (no hunting season), however free-ranging bison in the rest of the province (outside WBNP) are not given any consideration in the legislation, with the exception of the designation as "livestock" for purposes of compensation in Alberta's *Wildlife Act*. Therefore, bison on provincial lands that are not on ranches and are outside of the designated management area are not protected by legislation unless they are owned as livestock. The lack of protection provided for public bison herds in the area between the management zone and WBNP, was intended to provide a depopulation zone and may reduce the risk of infection of the Hay-Zama herd with diseases from WBNP, however its effectiveness has not been assessed. Although the Wildlife Regulation created under Alberta's *Wildlife Act* recognizes four subspecies of Elk as "Big Game" and two subspecies of Caribou as "Threatened" species, it does not recognize wood bison as a subspecies separate from plains bison.

2. Other Areas. - The Convention on the International Trade in Endangered Species (CITES) listed the wood bison in Appendix I in 1977, and downlisted it to Appendix II in 1997 (Gates et al. 2001). This international agreement regulates the import and export of animals for commercial purposes. The International Union for Conservation of Nature (IUCN) recognized the wood bison as conservation dependent in 1996 (RENEW 1998) and they have been listed in the IUCN Red Data Book which represents a global catalogue of species that are "At Risk" (IUCN 1996). The United Nations Educational, Scientific and Cultural Organization (UNESCO) identified WBNP as a World Heritage Site in 1983 predominantly because of the wildlife populations

(Parks Canada 1997). This World Heritage designation becomes important when considering options for management of the disease issue. On 19 November 1996, the Global Heritage Status Rank was determined to be G4T?Q, indicating remnant and reintroduced populations with some question about the validity of the subspecies (NatureServe 2001).

In 1970, the US Endangered Species Act (ESA) listed the wood bison as "Endangered" in Canada (RENEW 1998). There are currently no wood bison located in the US. However, this designation poses a potential problem to their reintroduction into their original range in Alaska because of import restrictions.

As of 1988, the Committee On the Status of Endangered Wildlife In Canada (COSEWIC) listed the wood bison as "Threatened" (FEARO 1990). Another national body, the committee on the Recovery of Nationally Endangered Wildlife (RENEW), recognizes the status of the wood bison through its recovery planning activities (Gates et al. 2001).

The legal designations for wood bison vary throughout the country. Under the Yukon Act of the federal government, the wood bison is listed as an "Endangered Species". The *Wildlife Act* of the Yukon government lists the wood bison as a "Specially Protected Species" (Yukon Government 1998). The Northwest Territories Act designates the wood bison as "being in danger of becoming extinct", and therefore regulates and restricts the hunting of wood bison (Gates et al. 2001). The government of the Northwest Territories created a Bison Control Area (depopulation zone) to prevent the transmission of diseases from WBNP to the Mackenzie Bison population. The government of British Columbia recognizes the wood bison as a "Species At Risk" and has therefore designated it as a protected species (Gates et al. 2001). In British Columbia, the wood bison is ranked S1 or "critically imperiled" and is on the provincial "Red List" of vulnerable or sensitive species (BC Conservation Data Centre 2001). British Columbia is also considering the establishment of a Bison Management Zone to prevent interbreeding between the Pink Mountain plains bison herd and the wood bison populations in northeastern British Columbia. This zone would match the existing Alberta management area and Northwest Territories Bison Control Area (Harper et al. 2000). Saskatchewan currently has no specific legislation or protection for wood bison populations. Under the Manitoba *Wildlife Act* the wood bison is listed as a "Protected Species" and the provincial government has established a wildlife management area in the area of Chitek Lake (Gates et al. 2001). The status of bison (both subspecies) according to Wild Species 2000 is summarized in Table 3 (CESCC 2001).

Table 3. Status of bison in Canada (CESCC 2001).

Region	Status
Canada	Sensitive
Alberta	At Risk
British Columbia	Sensitive
Manitoba	At Risk
Northwest Territories	At Risk
Ontario	Exotic
Saskatchewan	May Be At Risk

RECENT MANAGEMENT IN ALBERTA

In Alberta, free-ranging bison outside of the Bison Management Zone in the northwest quadrant of the province and outside of the national parks are not considered wildlife. This policy provides a measure to reduce the risk of infection of the Hay-Zama herd with tuberculosis and brucellosis. The reintroduced wood bison in the Hay-Zama area are being monitored and protected from hunting by both the provincial government and the Dene Tha' First Nation. Parks Canada manages the wood bison herds located within WBNP and EINP. EINP provides surplus animals from its

managed herds for reintroduction and conservation programs throughout the country.

In 1988, a Captive Ungulate Program was created by the Government of Canada because the health status of game farmed deer, elk and bison was not well known, and they posed a potential health risk for the spread of tuberculosis and brucellosis to Canadian cattle. In 1990, it became mandatory for a permit to be issued to move an animal, thus allowing for the monitoring of all movement of these species. Under the National Captive Ungulate Regulations, bison herds testing positive for one or more of the reportable diseases would be subject to slaughter. The economic cost to producers of such an action would be high, since losses from condemnation are not compensated at full market value. Furthermore, access to national and international markets may be affected if a disease outbreak occurs. The Canadian Bison Association (CBA) formed a committee in 1996 to develop an approach to disease risk management. In addition to captive bison ranching, commercial agriculture has also grown in the north, moving to within 70 km of WBNP in the 1980s (McCormack 1992). This growth of agricultural pursuits in northern Canada could limit the amount of suitable habitat available for the recovery of wood bison in the area.

In addition to the growing number of bison ranches in the area surrounding WBNP, the Peace Country Bison Association, in cooperation with Alberta Agriculture, Food and Rural Development (among others), have initiated a long-term grazing initiative in Fort Vermilion. This will establish a research pasture to address questions regarding bison (plains bison) grazing management in the north. The purpose of this project is to answer relevant questions relating to pasture management and its relationship with winter grazing. This is an issue that is currently limiting the expansion of the bison industry into northwestern Alberta. In 2000, an initiative was undertaken to support the development of the commercial bison industry in the Peace Country in northwestern Alberta. The site is a few kilometers from two known wild bison populations that range west of WBNP. It is difficult to determine the potential impact this may have on the recovery of wood bison; however, the expansion of bison ranching into the original range of wood bison is viewed as a challenge to conservation in northern Alberta and British Columbia (Gates et al. 2001).

A research program to provide a better understanding of bison ecology in the WBNP area was initiated in 1995 by the Minister of Canadian Heritage. There have been two projects funded to date by the Bison Research and Containment Program. The first project was a multi-year project conducted by the University of Saskatchewan. The project objectives were to assess the prevalence of the diseases in the park, their impact on bison reproduction and survival, and how they interact with wolf predation (Joly et al. 1998). Results from this research are expected in 2001. The second project partially funded by this program was developed to refine the disease risk assessment conducted by APFRAN. This research gathered local information on the movements and distribution of bison and bison habitat surrounding WBNP, and combined that with biogeographical information using a method known as friction modeling to refine the original risk assessment (J. Mitchell, in prep.).

Aboriginal groups have played a significant role in the recovery of the wood bison in Canada including the Dene Tha' First Nation in Alberta (Hay-Zama herd), the Little Red River Cree Nation and Tall Cree First Nation's concern with the Wentzel herd, the Deninu Kue' First Nation (Hook Lake wood bison Recovery Project), the Deh Gah Ghotie First Nation (Mackenzie population), the Peoples of Fort Liard and Nahanni Butte in NWT, the Waterhen First Nation in Manitoba (Chitek Lake herd), and the Doig First Nation in British Columbia (Ethithun Lake herd). On 20 February 2001, the Heart Lake

Band (Treaty Six Tribal Chiefs Association) in east central Alberta received 53 wood bison from EINP. The goal of the project is to re-establish wood bison to achieve ecosystem restoration, cultural revitalization, and economic opportunities for the aboriginal community. The plan also identifies the long-term objective of re-establishing a free-ranging population of wood bison near or in the Cold Lake Air Weapons Range.

SYNTHESIS

The wood bison was once distributed across much of northern Canada and was almost eliminated during the late 1800s. COSEWIC lists the wood bison (*Bison bison athabascae*) as "Threatened", and Alberta's *Wildlife Act* considers it an "Endangered" species. The wood bison in and around Wood Buffalo National Park (WBNP) represent the largest metapopulation in existence. The presence of bovine tuberculosis and bovine brucellosis in these herds is one of the greatest obstacles to the recovery of wood bison in northern Alberta. The infected bison populations have declined 80% since 1971 to approximately 2900 animals. During the same time period, as a result of recovery efforts, disease-free populations in the original wood bison range have increased more than 1000% to approximately 4800 animals (2800 wood bison and 2000 plains bison). The agricultural industry and governments currently support the recovery of free-ranging herds. However, if the diseases spread to the disease-free herds or commercial farming operations of cattle and bison, support would likely disappear. The commercial bison ranching industry has been growing in the region (the Peace Country of Alberta and British Columbia). The number of commercial bison farms has been increasing by approximately 15% per year and the number of bison on these farms has been increasing by approximately 25% per year (Hussey 1997). There are currently 250 farms in the Peace Country containing approximately 20 000 bison. Commercial cattle grazing is also expanding in the region and in the 1980s moved within 70 km of WBNP (McCormack 1992). Transmission of the diseases to cattle would threaten the national tuberculosis and brucellosis-free status for the domestic cattle herd and could potentially result in a cumulative economic loss of $1 billion over a 20 year period (FEARO 1990). The growth of the disease-free, free ranging herds and the commercial bison and cattle herds in combination with the persistence of the diseases in the region presents an issue that needs to be addressed through appropriate management planning.

LITERATURE CITED

Alberta Fish and Wildlife. 1985. A policy for the management of threatened wildlife in Alberta. Alberta Fish and Wildlife, Edmonton, AB. 34 pp.

Alberta Fish and Wildlife. 1991. The Status of Alberta Wildlife. Alberta Forestry, Lands, and Wildlife, Wildlife Management Branch, Edmonton, AB. 49 pp.

Alberta Natural Heritage Information Network. 2001. Elements on the Tracking List. Alberta Natural Heritage Information Centre (ANHIC). URL: http://www.gov.ab.ca/env/parks/anhic/anhic.html [Revision date: 6 April 2001].

Alberta Sustainable Resource Development. 2001. The General Status of Alberta Wild Species 2000. Alberta Sustainable Resource Development, Fish and Wildlife Service, Edmonton, AB. 46 pp.

Alberta Wildlife Management Division. 1996. The Status of Alberta Wildlife. Alberta Environmental Protection, Wildlife Management Division, Edmonton, AB. 44 pp.

Animal, Plant and Food Health Risk Assessment Network. 1998. Risk Assessment on Bovine Brucellosis and Tuberculosis in Wood Buffalo National Park and Area. Animal, Plant and Food Health Risk Assessment Network (APFRAN). Canadian Food Inspection Agency. September, 1998. 39 pp.

Banfield, A.W. 1974. The Mammals of Canada. Toronto, University of Toronto Press. 438 pp.

Banfield, A.W.F. and N.S. Novakowski. 1960. The survival of the wood bison (*Bison bison athabascae* Rhoads) in the Northwest Territories. Natural History Papers, Nat. Mus. of Man No. 8, 30 August 1960. 6 pp.

BC Conservation Data Centre. 2001. Tracking Lists. British Columbia Ministry of Environment, Lands, and Parks. URL: http://www.elp.gov.bc.ca/rib/wis/cdc.htm [Accessed: 30 April 2001].

Bigstone Cree Nation and Metis People of Kituskeenow. 1999. Kituskeenow cultural land-use and occupancy study. Calgary: Arctic Institute of North America: Bigstone Cree National and Metis People of Kituskeenow. 96 pp. plus ill., maps, ports.

Bison Research and Containment Program. 1996. Bison Research and Containment Program (BRCP). Wood Buffalo National Park, Heritage Canada. URL: http://www/auroranet.nt.ca/wbnp/bison/facts.htm [Accessed: 11 November 1997].

Campbell, C., I.D. Campbell, C.B Blyth, and J.H. Mcandrews. 1994. Bison extirpation may have caused aspen expansion in western Canada. Ecography 17:360-362.

Canadian Endangered Species Conservation Council (CESCC). 2001. Wild Species, 2000: The General Status of Species in Canada. Ottawa: Minister of Public Works and Government Services Canada. URL: http://www.wildspecies.ca [Revision date: 20 April 2001].

Carbyn L.N., N. Lunn and K. Timoney. 1998. Trends in the distribution and abundance

of bison in Wood Buffalo National Park. Wildl. Soc. Bull. 26:463-470.

Carbyn, L.N., S.M. Oosenbrug, and D.W. Anions. 1993. Wolves, bison and the dynamics related to the Peace-Athabasca Delta in Canada's Wood Buffalo National Park. Can. Circumpolar Res. Ser. No. 4, Canadian Circumpolar Institute, University of Alberta, Edmonton, AB. 270 pp.

Carbyn, L.N. and T.Trottier. 1988. Description of wolf attacks on bison calves in Wood Buffalo National Park. Arctic 41:297-302.

Cook, F.R. and D. Muir. 1984. The Committee on the Status of Endangered Wildlife in Canada (COSEWIC): history and progress. Can. Field-Nat. 98:63-70.

COSEWIC. 2001. Species at Risk in Canada. Committee on the Status of Endangered Wildlife in Canda. URL: http://www/cosewic.gc.ca [Revision date: October 2000].

Dary, D.A. 1989. The Buffalo Book: The Full Saga of the American Animal. Swallow Press/Ohio University Press.

Davis, D.S., J.W. Templeton, T.A. Ficht, J.D. Huber, R.D. Angus and L.G. Adams. 1991. *Brucella abortus* in bison. II. Evaluation of strain 19 vaccination of pregnant cows. J. Wildl. Dis. 27: 258-264.

Dirschl, H.J., D.L. Dabbs, and G.C. Gentle. 1974. Landscape classification and plant successional trends: Peace-Athabasca Delta. Can. Wildl. Rept. Ser. No. 30.

English, M.C., M.A. Stone, B. Hill, P.M. Wolfe, and R. Ormson. 1995. Assessment of impacts of Peace River impoundment at Hudson Hope, British Columbia on the Slave River Delta, NWT. NRBS Tech. Rept. No. 74 in Northern River Basins Study: The Legacy. The Collective Findings. Volume 1. Northern River Basins Study, Edmonton, AB.

Federal Environmental Assessment Review Panel (FEARO). 1990. Northern Diseased Bison. Report of the Environmental Assessment Panel, August 1990. Fed. Env. Assess. Rev. Office. 47 pp.

Ferguson, T.A., and F. Laviolette. 1992. A note on historical mortality in a northern bison population. Arctic 45(1): 47-50.

Flerov, C.C. 1965. Comparative craniology of recent representatives of the genus *Bison*. Bull. of the Moscow Nat. Soc. Dept. of Biol. Vol LXX, No. 1. 17pp.

Frank, D.A., and R.D. Evans. 1997. Effects of native grazers on grassland N cycling in Yellowstone National Park. Ecology 78(7):2238-2248.

Frank, D.A., and S.J. McNaughton. 1992. The ecology of plants, large mammalian herbivores, and drought in Yellowstone National Park. Ecology 73(6):2043-2058.

Fuller, W.A. 1962. The biology and management of the bison of Wood Buffalo National Park. Can. Wildl. Serv., Wildl. Manage. Bull. Ser. 1, No. 16:1-52.

Gainer, B. 1985. Free-roaming bison in northern Alberta. Alberta Nat. 15(3):86-87.

Gates, C.C. 1993. Biopolitics and pathobiology: Diseased bison in northern Canada. Pp. 271-282 in Proc. North American Public Bison Herds Symposium (R. E. Walker, symposium organizer and compiler). Lacrosse, WI, July 27-29, 1993. Custer State Park, Custer, SD. 444 pp.

Gates, C.C., T. Chowns, and H.W. Reynolds. 1992. Wood Buffalo at the Crossroads. Pp. 139-165 in Buffalo, (J. Foster, B. Harrison, and I.S. MacLaren, ed.). Alberta Nature and Culture Series, University of Alberta Press, Edmonton, AB.

Gates, C.C., B. Elkin and D. Dragon. 1995. Investigation, control and epizootiology of anthrax in an isolated, free-roaming bison population in northern Canada. Can. J. Vet. Res. 59:256-264.

Gates, C.C., B.T. Elkin, and D.C. Beaulieu. 1998. Initial results of an attempt to eradicate bovine tuberculosis and brucellosis from a wood bison herd in northern Canada. Pp. 221-228 in International Symposium on Bison Ecology and Management in North America, (Irby, L. and J. Knight, eds.). Montana State University, Bozeman, MT. 395 pp.

Gates, C.C., B. Elkin and D. Dragon. In Press. Anthrax. In Infectious diseases of wild mammals, 3rd edition. Iowa State University Press. (E.S. Williams, I.K. Barker and E.T. Thorne, eds.).

Gates, C.C., R.O. Stephenson, H.W. Reynolds, C.G. van Zyll de Jong, H. Schwantje, M. Hoefs, J. Nishi, N. Cool, J. Chisholm, A. James, and B. Koonz. 2001. National Recovery Plan for the wood bison (*Bison bison athabascae*). National Recovery Plan No. 21. Recovery of Nationally Endangered Wildlife (RENEW), Ottawa, ON.

Geist, V. 1991. Phantom subspecies: the wood bison *Bison bison athabascae* Rhoads 1897 is not a valid taxon, but an ecotype. Arctic 44:283-300.

Geist, V. and P. Karsten. 1977. The wood bison (*Bison bison athabascae* Rhoads 1989) in relation to hypotheses on the origin of the American bison (*Bison bison* Linnaeus). Zeitschrift fuer Saugetierkunde 42:119-127.

Green G.I., D.J. Mattson and J.M. Peek. 1997. Spring feeding on ungulate carcasses by grizzly bears in Yellowstone National Park. J. Wildl. Manage. 61(4):1040-1055.

Groves, C.P. 1981. Systematic relationships in the Bovini (Artiodactyla, Bovidae). Zeitschrift fur zoologischen Systematik und Evolutionsforschung. 19:264-278.

Guthrie, R.D. 1980. Bison and Man in North America. Canandian Journal of Anthropology 1:55-73.

Guthrie, R.D. 1982. Mammals of the Mammoth Steppe as Paleoenvironmental Indicators. Pp. 307-329 in Paleoecology of Beringia, (D. M. Hopkins, J.V. Matthews, Jr., C.E. Schweger, and S.B. Young, eds.). Academic Press, New York.

Guthrie, R.D. 1990. Frozen Fauna of the Mammoth Steppe: The Story of Blue

Babe. The University of Chicago Press, Chicago. 323 pp.

Harper, W.L., J.P. Elliott, I. Hatter, and H. Schwantje. 2000. Management plan for wood bison in British Columbia. B.C. Minist. Environ., Lands and Parks, Victoria, BC. 43pp.

Hogenbirk, J.C. and R.W. Wein. 1991. Fire and drought experiments in northern wetlands: a climate change analogue. Can. J. Botany 69:1991-1997.

Hogenbirk, J.C. and R.W. Wein. 1992. Temperature effects on seedling emergence from boreal wetland soils: implications for climate change. Aquatic Botany 42:361-373.

Hussey, G. 1997. Analysis carried out for the the Alberta Bison Association: Value of Bison Production 1997 estimates for Alberta. Hussey & Kilpatrick Associates, Calgary, AB.

International Union for Conservation of Nature. 1996. 1996 IUCN Red List of Threatened Animals. IUCN. Cambridge, United Kingdom.

Isenberg, A. C. 2000. The destruction of the bison: an environmental history, 1750-1920. Cambridge University Press, Cambridge.

Jacques, D.R. 1990. Vegetation habitat types of the Peace-Athabasca Delta: 1976-1989. A final report to Parks Canada, Wood Buffalo National Park, Ft. Smith, NWT. 65 pp.

Janecek , L.L., R.L. Honeycutt, R.M. Adkins, and S.K. Davis. 1996. Mitochondrial gene sequences and the molecular systematics of the Artiodactyl subfamily Bovinae. Mol. Genet. Evol. 6:107-119.

Joly, D., F.A. Leighton and F. Messier. 1998. Tuberculosis and brucellosis infection of bison in Wood Buffalo National Park, Canada: preliminary results. Pp. 23-31 in International Symposium on Bison Ecology and Management in North America. (Irby, L. and J. Knight, eds.). Montana State University, Bozeman, MT. 395 pp.

Joly, D.O. and F. Messier. 2001. Limiting effects of bovine brucellosis and tuberculosis on wood bison within Wood Buffalo National Park. Department of Biology, University of Saskatchewan, Saskatoon, SK, S7N 5E3. Final Report, March 2001. Submitted to: Wood Buffalo National Park, Heritage Canada, Box 750, Fort Smith, NT, X0E 0P0. 127 pp.

Jones C, R. S. Hoffmann, D. W. Rice, R. J. Baker, M. D. Engstrom, R. D. Bradley, D. J. Schmidly, and C. A. Jones. 1997. Revised checklist of North American mammals north of Mexico, 1997. Occas. Pap. No. 173. Museum of Texas Tech University, Lubbock, TX. 24 pp.

Karsten, P. 1975. Don't be buffaloed...by a bison: history of Alberta herds. Dinny's Digest, Calgary Zool. Soc. 2:3-13.

Komers, P.E., F. Messier, P.F. Flood and C. C. Gates. 1994a. Reproductive behaviour of male wood bison related to female progesterone level. J. Mammalogy 75:757-765.

Komers, P.E., F. Messier and C.C. Gates. 1994b. Plasticity of reproductive behaviour in

wood bison bulls: when subadults are given a chance. Ethology Ecology and Evolution 6:313-330.

Larter, N.C. and C.C. Gates. 1991. Diet and habitat selection of wood bison in relation to seasonal change in forage quantity and quality. Can. J. Zool. 69:2677-2685.

Larter, N.C., A.R.E. Sinclair and C.C. Gates. 1994. The response of predators to an erupting bison, *Bison bison athabascae*, population. Can. Field-Nat. 108:318-327.

Lewis, H.T. 1977. Maskuta: The ecology of Indian fires in northern Alberta. Western Canadian J. Anthropol. 7:15.

Lewis, H.T. 1980. Indian Fires of Spring. Natural History 89:76-83.

Lewis, H.T., and T.A. Ferguson. 1988. Yards, corridors and mosaics: How to burn a boreal forest. Human Ecol. 16:57-77.

Lott, D.F., and J.C. Galland. 1985. Individual variation in fecundity in an American bison population. Mammalia 49(2):300-302.

McCormack, P.A. 1992. The political economy of bison management in Wood Buffalo National Park. Arctic 45(4):367-380.

Messier, F. 1989. Effects of bison population changes on wolf-prey dynamics in and around Wood Buffalo National Park. Pp. 229-262 in Northern Diseased Bison Environmental Assessment Panel: Compendium of government submissions and technical specialists reports in response to the Panel information requirements document. Federal Environmental Assessment Review Office, Ottawa, ON. 295 pp.

Mitchell, J. In prep. A Profile of tuberculosis and brucellosis risk for bison in Northern Canada. Master of Environmental Design Thesis Dissertation. Faculty of Environmental Design, University of Calgary, Calgary, AB.

Mitchell, J. and C. Gates. In press. An approach to disease risk management for wood bison (*Bison bison athabascae*) in northern Canada. Ungulate Ecology and Management, Nelson, BC 24-28 August 1999.

Miyamoto, M.M., S.M. Tanhauser, and P.J. Laipis. 1989. Systematic relationships in the artiodactyl tribe Bovini (Family Bovidae), as determined from mitochondrial DNA sequences. Systematic Zoology 38:342-349.

Moss, E.H. 1952. Grassland of the Peace River region, western Canada. Canadian J. Botany 30:98-124.

Moss, E.H. 1953. Marsh and bog vegetation in northwestern Alberta. Canadian J. Botany 31:448-470.

Morton, K. 1999. Wood Bison Re-Introduction Hay-Zama Herd: Progress Report – April 1999. Unpubl. rept. for Alberta Environmental Protection, Natural Resources Service, High Level, AB. 21 pp.

Muzik, I. 1986. The cause and effect of low flows on the Peace-Athabasca Delta. Pp. 147-158 in Drought: The Impending Crisis? Proceedings of the Canadian Hydrology Symposium (CHS 86), 3-6 June 1986, at Regina, SK, Canada.

National research Council of Canada, Associate Committee on Hydrology, Ottawa, ON.

National Parks Service, USA. 1999. DRAFT Environmental Impact Statement for the Interagency Bison Management Plan for the State of Montana and Yellowstone National Park. February 21, 1999. URL: http://www.nps.gov/planning/yell/eis/summary.htm [Revision date: 10 February 2000].

National Research Council. 1995. Science and the Endangered Species Act. National Academy Press, Washington, DC. 271 pp.

NatureServe: An online encyclopedia of life [web application]. 2001. Version 1.4. Arlington, Virginia, USA: Association for Biodiversity Information. URL: http://www.natureserve.org/ [Accessed: 30 April 2001].

Novakowski, N.S. 1957. Aerial resurvey of bison in Wood Buffalo National Park and surrounding areas, 1957. Unpubl. rept. for Can. Wildl. Serv., Edmonton, AB. CWSC-216. 12 pp. + maps.

Parks Canada. 1997. URL: http://www.parkscanada.gc.ca/parks/nwtw/wood_buffalo/english/nature_e.htm [Revision date: 16 January 2001].

Pastor, J., and W.M. Post. 1988. Response of northern forests to CO2-induced climate change. Nature 334:55-88.

Polley, H.W. and S.L. Collins. 1984. Relationships of vegetation and environment in buffalo wallows. Am. Midl. Nat. 112(1): 178-186.

Raup, H.M. 1933. Range conditions in the Wood Buffalo Park of western Canada with notes on the history of the wood bison. Spec. Pub. Am. Comm. for Int. Wildlife Prot. 1(2) 52 pp.

Raup, H. M. 1935. Botanical investigations in Wood Buffalo Park, Canada, Department of Mines and the National Museum of Canada, Bulletin No. 74.

Redmann, R.E. and A.G. Schwarz. 1986. Dry grassland plant communities in Wood Buffalo National Park, Alberta. Can. Field-Naturalist 100:526-532.

Renecker, L.A., C.B. Blyth and C.C. Gates. 1989. Game production in western Canada. Pp. 248-267 In Wildlife Production Systems: Economic Utilization of Wild Ungulates (R.J. Hudson, K.R. Drew and L.M. Baskin, eds.). Cambridge Univ. Press.

RENEW. 1998. RENEW Report No. 8. Recovery of Nationally Endangered Wildlife. Canadian Wildlife Service. Published by the Minister of Public Works and Government Services Canada.

Reynolds, H. W. 1987. Description of the Slave River Lowlands. In Bison ecology in relation to agricultural development in the Slave River Lowlands, NWT (H.W. Reynolds and A.W.L. Hawley, eds.). Occas. Pap. No. 63, Can. Wildl. Serv.

Reynolds, H.W., R.M. Hansen and D.G. Peden. 1978. Diets of the Slave River Lowlands bison herd, Northwest Territories, Canada. J. Wildl. Manage. 42:581-590.

Reynolds, H.W. and A.W.L. Hawley (eds.). 1987. Bison Ecology in relation to agricultural development in the Slave River Lowlands, NWT. Occas. Pap. No. 63. Can. Wildl. Serv., Minister of Supply and Services Canada 1987. Cat No. CW 69-1/63E, 74 pp.

Reynolds, H.W., G.M. Lynch and B.L. Lajeunesse. 1982. Range Assessment of the Hay-Zama Lakes Area, Alberta, as habitat for wood bison and a proposal for their re-introduction. Unpubl. rept. for Alberta Environmental Protection, Natural Resources Service, Edmonton, AB. 47 pp.

Roe, F.G. 1951. The North American buffalo: A critical study of the species in its wild state. University of Toronto Press, Toronto, ON.

Simpson, G.G. 1961. Principles of animal taxonomy. Columbia Univ. Press, New York, NY. 247 pp.

Skinner, M.F. and O.C. Kaisen. 1947. The fossil *Bison* of Alaska and preliminary revision of the genus. Bull. Am. Mus. Nat. Hist. 89:131-256. 26 pp.

Soper, J.D. 1941. History, range and home life of the northern bison. Ecological Monographs 11:347-412.

Stephenson, R.O, S. C. Gerlach, R. D. Guthrie, C. R. Harington, R.O. Mills and G. Hare. In press. wood bison in late Holocene Alaska and adjacent Canada: Paleontological, archaeological and historical records. Wildlife and People in Northern North America. Essays in Honor of R. Dale Guthrie. (S. C. Gerlach and M. S. Murray, eds.). British Archaeological Reports, International Series.

Strobeck, C., R.O. Polziehn and R. Beech. 1993. Genetic relationship between wood and plains bison assayed using mitochondrial DNA sequence. Pages 209-227 in Proc. North American public bison herds symposium, (R.E. Walker, symposium organizer and compiler), Lacrosse, WI. July 27-29, 1993, Custer State Park, Custer, SD. 444 pp.

Tessaro, S.V. 1988. A descriptive and epizootiologic study of brucellosis and tuberculosis in bison in northern Canada. Ph.D. thesis, University of Saskatchewan, Saskatoon, SK. 320 pp.

Tessaro, S.V. 1989. Review of the diseased, parasites and miscellaneous pathological conditions of North American bison. Can. Vet. J. 30:416-422.

Timoney, K. 1996. Peace-Athabasca Delta Technical Studies Vegetation Monitoring. Task E.2 Unpubl. Final Rept. Parks Canada, Wood Buffalo National Park, Ft. Smith, NT.

Timoney, K., G. Peterson, P. Fargey, M. Peterson, S. McCanny, and R. Wein. 1997. Spring ice-jam flooding of the Peace-Athabasca Delta: Evidence of a climatic oscillation. Climate Change 35:463-483.

US Fish and Wildlife Service. 2001. Species Information: Threatened and Endangered Animals and Plants. Washington D.C. 20240. URL: http://endangered.fws.gov/ [Revision date: 9 July 2001].

Van Camp, J. and G.W. Calef. 1987. Population dynamics of bison. Pages 21-23 in Bison ecology in relation to agriculture development in the Slave River lowlands, NWT., (H.W. Reynolds and A.W.L.

Hawley, eds.). Canadian Wildlife Service. Occas. Pap. No. 63, Can. Wildl. Serv., Minister of Supply and Services Canada 1987. Cat No. CW 69-1/63E. 74 pp.

Van Gelden, R. 1977. Mammalian hybrids and generic limits. Am. Mus. Noviates 2635:1-25.

van Zyll de Jong C.G. 1986. A systematic study of recent bison, with particular consideration of the wood bison. Nat. Mus. Nat. Sci. Publ. in Nat. Sci. No. 6. 69 pp.

van Zyll de Jong, C.G., C. Gates, H. Reynolds, and W. Olson. 1995. Phenotypic variation in remnant populations of North American bison. J. Mammal. 76:391-405.

Wall, A.D., S.K. Davis, and B.M. Reed. 1992. Phylogenetic relationships in the subfamily bovinae (Mammalia – Artiodactyla) based on ribosomal DNA. J. Mammal. 73:262-275.

Wilkinson, K. and E.A. Johnson. 1983. Distribution of prairies and solonetzic soils in the Peace River District, AB. Canadian J. Botany 61:1851-1860.

Wilson, A.C., R.L. Cann, S.M. Carr, M. George, U.B. Gyllensten, K.M. Helm-Gychowski, R.G Higuchi, S.R. Palumbi, E.M. Prager, R.D. Sage and M. Stoneking. 1985. Mitochondrial DNA and two perspectives on evolutionary genetics. Biol. J. Linn. Soc. 26:375-400.

Wilson, D. E., and D. M. Reeder (eds.). 1993. Mammal Species of the World. Smithsonian Institution Press, Washington, DC. 1206 pp.

Wilson, G. and C. Strobeck. 1999. Genetic variation within and relatedness among wood and plains bison populations. Genome 42:483-496.

Wolff, J. O. 1998. Breeding strategies, mate choice, and reproductive success in American bison. Oikos 83(3):529-544.

Wright, K.D., and A. Markiewicz. 2000. wood bison (*Bison bison athabascae*) habitat mapping and enhancement study in the Hay-Zama lowlands 1999/2000. Alberta Conservation Association, Northwest Boreal Region, Peace River, AB.

Yukon Government. 1998. Yukon bison management plan 1998-2003. Unpubl. rept. for Dept. Renew. Resour., Yukon Government. Whitehorse, YK. 20 pp.

Zimov, S.A., V.I. Chuprynin, A.P. Oreshko, F.S. Chapin III, J.F. Reynolds, and M.C. Chapin. 1995. Steppe-tundra transition: A herbivore-driven biome shift at the end of the Pleistocene. The American Naturalist 146(5):765-794.

APPENDIX 1. Definitions of selected legal and protective designations.

A. The General Status of Alberta Wild Species 2000 (after Alberta Sustainable Resource Development 2001)

2000 Rank	1996 Rank	Definitions
At Risk	Red	Any species known to be "At Risk" after formal assessment and designation as Endangered in Alberta or in Canada (in the part of the range that includes Alberta).
May Be At Risk	Blue	Any species believed to be "At Risk". These species will require a detailed assessment for possible formal designation as Endangered or Vulnerable.
Sensitive	Yellow	Any species known to be, or believed to be, particularly sensitive to human activities or natural events.
Secure	Green	Any species known to be, or believed to be, not at risk.
Undetermined	Status Undetermined	Any species where not enough information exists to adequately use the ranking system (exceptional cases only).
Not Assessed	n/a	Any species known or believed to be present but which have not yet been evaluated.
Exotic/Alien	n/a	Any species that have been introduced as a result of human activity.
Extirpated/Extinct	n/a	Any species no longer thought to be present in the jurisdiction or are believed to be extinct.
Accidental/Vagrant	n/a	Any species occurring infrequently and unpredictably outside their usual range.

B. Alberta's *Wildlife Act*

Species designated as "Endangered" under Alberta's *Wildlife Act* include those defined as "Endangered" or "Threatened" by *A Policy for the Management of Threatened Wildlife in Alberta* (Alberta Fish and Wildlife 1985):

Endangered	A species whose present existence in Alberta is in danger of extinction within the next decade.
Threatened	A species that is likely to become endangered if the factors causing its vulnerability are not reversed.

C. United States Endangered Species Act (after National Research Council 1995)

Endangered	Any species which is in danger of extinction throughout all or a significant portion of its range.
Threatened	Any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

D. Committee on the Status of Endangered Wildlife in Canada (after COSEWIC 2001)

Extinct	A wildlife species that no longer exists.
Extirpated	A wildlife species that no longer exists in the wild in Canada, but exists elsewhere in the wild.
Endangered	A wildlife species that is facing imminent extirpation or extinction.
Threatened	A wildlife species that is likely to become an endangered species if nothing is done to reverse the factors leading to its extirpation or extinction.
Special Concern (Vulnerable)	A wildlife species of special concern because it is particularly sensitive to human activities or natural events, but does not include an extirpated, endangered or threatened species.
Not at Risk	A wildlife species that has been evaluated and found to be not at risk.
Indeterminate	A species for which there is insufficient scientific information to support status designations.

E. Heritage Status Ranks: Global (G), National (N), Sub-National (S) (after NatureServe 2001)

G1/N1/ S1	**Critically Imperiled**: Critically imperiled globally because of extreme rarity or because of some factor(s) making it especially vulnerable to extinction. Typically 5 or fewer occurrences or very few remaining individuals (<1000) or acres (<2000) or linear miles (<10).
G2/N2/ S2	**Imperiled**: Imperiled globally because of rarity or because of some factor(s) making it very vulnerable to extinction or elimination. Typically 6 to 20 occurrences or few remaining individuals (1000 to 3000) or acres (20 00 to 10 000) or linear miles (10 to 50).
G3/N3/ S3	**Vulnerable**: Vulnerable globally either because very rare and local throughout its range, found only in a restricted range (even if abundant at some locations), or because of other factors making it vulnerable to extinction or elimination. Typically 21 to 100 occurrences or between 3000 and 10 000 individuals.
G4/N4/ S4	**Apparently Secure**: Uncommon but not rare (although it may be rare in parts of its range, particularly on the periphery), and usually widespread. Apparently not vulnerable in most of its range, but possibly cause for long-term concern. Typically more than 100 occurrences and more than 10 000 individuals.
G5/N5/ S5	**Secure**: Common, widespread, and abundant (although it may be rare in parts of its range, particularly on the periphery). Not vulnerable in most of its range. Typically with considerably more than 100 occurrences and more than 10 000 individuals.
GX/NX/ SX	**Presumed Extirpated**—Element is believed to be extirpated from the nation or subnation*. Not located despite intensive searches of historical sites and other appropriate habitat, and virtually no likelihood that it will be rediscovered.
GH/NH/ SH	**Possibly Extirpated** (Historical)—Element occurred historically in the nation or subnation*, and there is some expectation that it may be rediscovered. Its presence may not have been verified in the past 20 years. An element would become NH or SH without such a 20-year delay if the only known occurrences in a nation or subnation were destroyed or if it had been extensively and unsuccessfully looked for. Upon verification of an extant occurrence, NH or SH-ranked elements would typically receive an N1 or S1 rank. The NH or SH rank should be reserved for elements for which some effort has been made to relocate occurrences, rather than simply using this rank for all elements not known from verified extant occurrences.

APPENDIX 2. Timeline summarizing the history of the wood bison.

YEAR	EVENT
PRE 1800	Bison were plentiful within their original range in Canada. Soper (1941) estimated 168 000 animals prior to European arrival.
1890s	Bison in the Wood Buffalo National Park area reached an estimated low of 250.
1897	S N. Rhoads identified the wood bison as a subspecies, creating two taxa within North America, Plains Bison (*Bison bison bison*), and wood bison (*Bison bison athabascae*).
1906	The Canadian government agreed to purchase a herd of endangered Plains Bison, known as the Pablo-Allard herd, from Montana rancher Michel Pablo, 310 Plains Bison were transported to Elk Island National Park (EINP) and approximately 750 Plains Bison were brought to the enclosed Buffalo National Park (BNP) in Wainwright, Alberta.
1921	BNP Plains Bison number greater than 5000 animals and were rapidly outgrowing the capacity of their range.
1922	WBNP was established. Estimates indicated the wood bison population to be approximately 1500 – 2000 animals.
1925-1928	A total of 6673 Plains Bison (yearlings, two and three year olds) were transported from BNP in Wainwright to Hay Camp in WBNP, however it is was unclear how many survived the trip. At the time the wood bison population in the park was estimated at 2000 animals.
Late 1930s	The bison population of the WBNP was estimated at 12 000, lower than the perceived regional carrying capacity. Wolves were subsequently poisoned and trapped in an attempt to increase the number of bison.
1940	The 'pure' wood bison was believed to be extinct as a result of crossbreeding with the introduced Plains Bison.
1959	Approximately 200 bison were discovered near the Nyarling River in the northwest corner of the Park. Anatomical comparisons indicated that they represented wood bison, although comparative studies were not carried out.
1963	A total of 18 disease-free wood bison from the Nyarling River area were transported to what became the Mackenzie Bison Sanctuary (MBS).
1965/68	Twenty-three wood bison were transported from the Nyarling River herd to Elk Island National Park (EINP).
1970	The bison population in the Greater WBNP area began to decline.
1974	Approximately 3000 bison drowned when they fell through the ice of the flooded Peace-Athabasca Delta.

APPENDIX 2. Continued

YEAR	EVENT
1977	Wood bison listed on Appendix I of the Convention on International Trade in Endangered Species (CITES) controlling exportation and importation of endangered wildlife species and products (subsequently downlisted to Appendix II in 1997).
1978	The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) listed the wood bison as "Endangered" (subsequently down-listed to "Threatened" in 1988). The governments of Alberta and the Northwest Territories protected bison, however 'hybrid' animals outside of the Park were subject to regional hunting. In Alberta, there were no regulations governing the hunting of bison outside of the park, except the Hay-Zama herd.
1980-1991	Wood bison herds were started from EINP animals: Nahanni National Park in 1980 (Nahanni population), Interlake region of Manitoba 1991 (Chitek Lake herd), Hay-Zama lakes Alberta 1984 (Hay-Zama herd) and the Nisling River Yukon 1980 (Yukon herd).
1995-1996	Fifty wood bison were reintroduced to the Upper Liard River valley in British Columbia (Nordquist herd) and 18 wood bison from Northern Lights College in Dawson Creek were released near Etthithun and Kantah Lakes, British Columbia (Etthithun Lake herd).
1996	The Hook Lake recovery project was initiated. Over three years, 60 calves were captured from the Hook Lake herd in the Slave River Lowlands, monitored for disease, and used to establish a healthy captive breeding herd.
2001	Collaborating agencies forming the National Recovery Team published a National Recovery Plan. The primary goal is to remove the wood bison from "Threatened" status by establishing at least four self-sustaining populations, each at or above a minimal viable population of 400 in original range.

APPENDIX 3. History of the tuberculosis and brucellosis in northern Canada (FEARO 1990, McCormack 1992, BRCP 1996, Gates et al. 2001).

YEAR	EVENT
1917	A Wainwright bison died from tuberculosis thought to have been contracted from local cattle herds.
Mid 1920s	Plains Bison infected with cattle diseases released into WBNP.
Late 1930s	Tuberculosis symptoms observed in bison in WBNP, disease presence confirmed in 1947.
1956	Brucellosis first tested for and confirmed in WBNP.
1980s	Agricultural grazing increases in the region, within 70 km of the Park boundary, creating a concern of disease transmission to domestic animals (cattle, bison and elk).
1985	Canadian domestic cattle herd is declared 'bovine brucellosis-free' and tuberculosis has almost been eliminated in the domestic stock. (Sporadic tuberculosis outbreaks have continued to occur, one in Quebec in 1989 and another in Manitoba in 1997 (D. Scott, pers. comm. 1999), but can be traced to imported stock).
1988	Elimination or control of the diseases in the bison is listed as a management priority.
1989-1990	Federal Environmental Assessment of disease issue – replacement with healthy wood bison recommended.
1996	NWT and Deninu Kue First Nation initiate a genetic salvage and disease eradication project in the Slave River Lowlands.
1996	Wood Buffalo National Park initiates a research project on the effects of brucellosis and tuberculosis on bison in the park.
2000	Peace Country Bison Association and the Government of Alberta initiate a northern Alberta commercial bison grazing experiment at Fort Vermilion.

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